

STITCHING TECHNIQUES  
FOR SLACK MERCERIZED COTTON STRETCH DENIM

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by

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A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Clothing and Textiles,  
Home Economics

KANSAS STATE UNIVERSITY  
Manhattan, Kansas

1967

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#### ACKNOWLEDGMENTS

The author wishes to express her sincere gratitude to her Major Professor, Dr. Jessie Warden, Head of the Clothing and Textiles Department, for her guidance and assistance in the preparation of this Report.

Heartfelt thanks are also extended to her husband, Lemuel E. Wynn, for his encouragement and help, both physical and emotional, throughout this study.

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## CHAPTER I

### INTRODUCTION

This study was undertaken to determine stitching techniques for slack mercerized cotton comfort stretch denim fabric with the seams judged for quality of appearance on the right side. It was believed that persons involved in home sewing are very interested in the outside appearance of finished garments. Stretch fabrics have presented problems when used for garment construction.

Stretch fabrics are fabrics that stretch from 10 to 50 per cent or more with 80 to 98 per cent recovery. Stretch fabrics were first made by using synthetic or natural rubber. Further textile technology developed finishing techniques for making regular man-made yarns into stretch yarns. The idea of producing stretch yarns or fabrics by use of finishing processes grew to include the natural fibers.

Stretch fabrics were used in and widely accepted as ready-made garments. Later stretch fabrics were made available in yard goods. The use of stretch fabrics for construction of apparel garments has presented problems. Keeney (17) related that the use of stretch fabrics for construction of apparel garments by the garment construction industry has presented problems in fabric layout,

knives used in cutting, kind of seams, thread to be used, and pressing. If the garment industry has problems with stretch fabrics, it is conceivable that persons engaged in home sewing may also have problems when working with stretch fabrics. The strength, elasticity, and launderbility of various kinds of seams and other construction processes on stretch fabrics using different threads have been tested by several resesrchers. Their findings are availble to home economics students and other persons engaged in home sewing.

In addition to problems of seam strength, elasticity, and launderbility of samples and articles made from stretch fabrics is the problem of seam appearsnce of stretch fabrics. Seam puckering and other fabric damage is frequently encountered when sewing with stretch fabrics. Douty (12, page 464) stated that "Puckered seams are not in the tradition expected of high quality garments."

The specific purpose of this study was to determine stitching techniques for slack mercerized cotton stretch denim.

Cotton stretch fabric was one of the first natural fibers to be processed to achieve the stretch factor. Slack mercerization is the process used to produce existing cotton stretch fabrics. Twill weave was selected as a result of a market survey of ready-made stretch trousers for women, which revealed the availability of stretch denim in the Greater Kansas City area. One hundred per cent cotton

stretch denim was available in yard goods in the Greater Kansas City area.

It was hoped that this study would help home economists determine stitching techniques for use on slack mercerized cotton stretch denim and other stretch fabrics. Such information may be available to students engaged in making garments from slack mercerized cotton comfort stretch denim fabric and serve as possible basis for work with other stretch fabrics.

## CHAPTER II

### REVIEW OF THE LITERATURE

Four processes which have been developed for producing stretch cotton fabrics will be discussed. Cotton stretch fabrics can be produced with different percentages of stretch and recovery. The question of how much fabric stretch and recovery are needed to yield comfortable, stable garments has arisen in the textile and garment industries. Problems of fabric stretch for garment construction and some suggested solutions will be included in the review of literature. In addition to problems of fabric stretch are the problems of garment construction, wearing qualities, and launderability of cotton stretch fabrics. Suggestions on construction techniques and research from selected studies dealing with these problems will be reviewed.

#### Processes for Producing Stretch Cotton

Of the four processes evolved for producing stretch cottons, three have been designed for imparting stretch to cotton yarns and the fourth for imparting stretch to cotton fabrics after weaving. All processes discussed are still under development or improvement; however, the fourth process has been most successful to date.

Crosslinking process. The crosslinking process for making cotton stretch yarns using the backtwist and false-twist techniques was described by Sloan (24). The backtwist technique uses highly twisted plied cotton yarns that are wet-out with a solution of a crosslinking agent, dried, cured, then backtwisted beyond neutral ply twist.

The falsetwist technique uses plied cotton yarns that are wet-out with a solution of a crosslinking agent and put through a falsetwist machine. Acetylation, cyanoethylation, and dimethylol ethyleneurea (DMEU), as reported by Modern Textiles Magazine (4), are resins used in the crosslinking process.

Cotton yarns treated with the crosslinking process to impart the stretch factor are bulky, textured, and highly stretchable with approximately 50 per cent decrease in yarn strength. Brown (3) reported the properties and uses for fabrics made from crosslinked cotton yarns. The total elongation of crosslinked yarns was reported to be approximately 400 per cent. Experimental fabrics woven with crosslinked yarns have total elongation-at-break of 80 per cent, and are thicker, lower in bulk density, less permeable to air-flow, and better thermal insulators than comparable fabrics woven from untreated cotton yarns. These fabrics could be used for sportswear, children's clothing, shirts, dresses, shawls, and men's hose. Experimental fabrics made from crosslinked cotton yarns are washable.

Heat-setting process. Three methods of the heat-setting process for producing cotton stretch yarns were described in American Fabrics Magazine (7) as being false-twist, stuffer box, and knife edge methods. Cotton yarns are treated with acrylonitrile, acetate anhydride, or other chemicals to give them thermoplastic properties. The chemically modified yarns are heated and crimped by one of the three heat-set processes the same as man-made thermoplastic fibers and yarns.

The false-twist method for heat-setting cotton yarns is accomplished by twisting, heating, and untwisting cotton yarns. The false-twist method produces cotton stretch yarns with coil shape.

The stuffer box method for heat-setting cotton yarns is achieved by forcing yarns into a stuffer box with the speed of the yarns entering the box greater than the speed of the yarns leaving the box. The yarns are heated in the stuffer box in the crimped condition and released. The yarns have a rounded crimp shape.

The knife edge method for heat-setting cotton yarns is carried out by heating the yarns and drawing across a knife edge. The yarns have a spiral coil shape.

The properties of heat-set cotton stretch yarns, as reported by Fisher (13), were resistant to rot and heat, with high stretch and elongation-at-break. No other properties of experimental fabrics from heat-set yarns were

reported. Heat-set cotton stretch yarns may be made into fabric for garments where power or action control is needed, such as in skiwear, foundation garments, swim wear, and athletic clothing, according to the National Cotton Council (25).

Hydrogen bond rearrangement process. A third method for producing cotton stretch yarns was mentioned by Decossae (10) as being the swelling treatment for hydrogen bond rearrangement. No other references were found that mentioned this third method of producing cotton stretch yarns. It was assumed that the process is under development.

Slack mercerization process. The study of slack mercerization was started in the 1940's. Fisher (13, page 44) stated that "Charles F. Goldthwait may be considered the father of slack mercerization." Slack mercerization may be used to impart stretch to cotton fibers, yarns, and fabric.

Slack mercerization is achieved, as described in American Fabrics Magazine (6), by allowing cotton fibers, yarns or fabric to shrink without tension in a mercerizing bath of sodium hydroxide solution. Slack mercerization is followed by several water-washings and other fiber, yarn, or fabric processes.

Production of slack mercerized cotton fibers by tensionless procedures and a study of physical properties and chemical behavior of these fibers when woven and knitted

into fabric were the purposes of experimental work reported by Rutherford (21). It was found that 16 per cent concentration of sodium hydroxide was the optimum concentration for tensionless mercerization of cotton fibers. The maximum shrinkage was about 15 per cent, and the increased elongation-at-break was from 7.5 per cent for the untreated fiber to 12 per cent for the mercerized fiber. The cord eliver (flat band of loose fibers) was suggested as the best form in which to mercerize the fibers.

Yarns spun from mercerized eliver showed high elongation and better strength and appearance than those spun from untreated cotton. The increased elongation of the mercerized single fibers was not completely utilized in the yarns made from these fibers. The maximum elongation of the yarns was only 10.7 per cent. It was found that the recovery of single and ply yarns made from the untreated fibers was superior to the yarns made from the mercerized eliver.

Yarns spun from elect mercerized cotton fibers and regular cotton yarns were used to make woven and knitted fabrics. The strength of all fabrics appeared to be very nearly the same. No particular advantage with respect to resin treatment or dyestuff receptivity were gained by bulk fiber mercerization.

Findings on elect mercerized cotton fibers reported by Grant (15) and Sloan (23) were in part contradictory of Rutherford's findings. Grant stated that if cotton fibers

are allowed to contract in length during mercerization, the decrease in the length due to shrinkage is about 18 per cent with an increase in fiber diameter. The increase in diameter is due to swelling of the secondary walls and filling of the lumen removing the convolutions. The decreased length and increased diameter provide the fiber with stretchability and recovery. Although Sloan (23) did not report the specific percentage of fiber shrinkage, he said that the fibers shrink in length and swell laterally, producing a more rounded shape.

Grant and Sloan reported that the ultimate length of the slack mercerized single fiber at break was slightly below that of the untreated cotton fiber. The decrease in cellulose density and the increase in volume indicated a more porous structure in the mercerized fiber. The porous structure will increase dye affinity. Fiber strength was about the same for mercerized as for untreated cotton fibers.

The differences in the findings of Grant, Sloan, and Rutherford may be explained by the facts that the latter's findings were based on slack mercerized bulk cotton fibers. Grant's and Sloan's findings were based on fibers drawn from slack mercerized fabrics. The slack mercerization of cotton fibers is still under development.

Procedures for producing slack mercerized cotton yarns was reported in Modern Textiles Magazine (4) according to mercerization with and without tension. Cotton yarns

have an elongation of 70 per cent when mercerized under tension. Elongation was decreased from 70 per cent to 40 to 55 per cent for cotton yarns mercerized without tension. Recovery percentages rose from 65 per cent when mercerized under tension to well above 80 per cent when mercerized without tension. The stretch and recovery powers of fabrics made from slack mercerized cotton yarns are very good for some uses, but not good for power stretch, according to Modern Textiles Magazine (4). Slack mercerization of cotton yarns also is under development.

To date, slack mercerization of cotton fabrics rather than of cotton fibers or yarns has been the most successful. Cotton fabrics or cotton combination fabrics are allowed to shrink without tension or with tension in one direction, in a solution of sodium hydroxide. Several references differed as to the concentration of the sodium hydroxide solution recommended. Modern Textiles Magazine (4) reported the concentration to be 23 per cent at 170 degrees Fahrenheit for about one and one-half minutes. Sloan (22) reported the concentration of the solution to be 25 to 30 per cent at thirty degrees Centigrade or lower. Sloan (23) reported that maximum fabric shrinkage was obtained in 32 per cent solution of sodium hydroxide at twenty-five to thirty-five degrees Centigrade. Sloan (24) stated that maximum shrinkage occurs in 32 per cent concentration of sodium hydroxide solution, but nearly as good shrinkage is obtained at 23

per cent.

Temperature for mercerization did not materially affect fabric shrinkage when stronger solution concentrations of 23 to 32 per cent were used, according to Sloan (24), but at the lower concentrations fabric shrinkage was affected by temperature, with maximum shrinkage occurring at zero degrees Centigrade. The National Cotton Council (25) reported that the amount of shrinkage of cotton fabrics during mercerization is determined in part by the concentration and temperature of the sodium hydroxide solution. Using the statements from the above references, it was concluded that the concentration of the sodium hydroxide solution may be 23 to 32 per cent, depending upon mercerizing temperature and the amount of shrinkage desired.

The amount of fabric shrinkage during mercerization is important since the amount of elongation obtained in a fabric is directly proportional to the sum of the original elongation and the shrinkage occurring during mercerization. Sloan (23) and Fisher (13) described factors that influence fabric shrinkage during mercerization. Sloan reported that Shrinkage was influenced by the number of yarns per inch shrinking in a given direction and the number of yarns resisting shrinkage. Fisher stated that shrinkage is favored by lack of tension and high twist for yarns. Both agreed that loose fabric constructions facilitated increase in fabric shrinkage and thickness. The National Cotton Council

(25) related that fabric shrinkage was influenced by fabric density and weave.

All references agreed on the steps of processing the fabric after shrinkage. The fabrics are neutralized, water-washed several times, and dried. Sloan (24) related that fabrics may be slack mercerized either before or after scouring and bleaching. Cotton fabrics may be slack mercerized with or without crosslinking agents.

Slack mercerization may be used to produce comfort filling one-way stretch or two-way comfort stretch cotton fabrics. Comfort filling stretch fabrics by slack mercerization, according to Sloan (24), have an easy stretch of 20 to 30 per cent in the filling direction only, with a 20 to 30 per cent increase in warp thread count and fabric weight. Easy stretch was defined as needing less than four pounds of stress per inch to extend the fabric. The fabric had 2 to 4 per cent fabric growth after prolonged extension. Fabric growth was defined as the percentage of increase in the dimensions of stretch fabrics after being extended and the load removed. Comfort stretch fabrics, one-way and two-way, have less extensibility than action stretch fabrics.

Comfort filling stretch fabrics by slack mercerization are accomplished by allowing the fabric to shrink only in the filling direction while holding the warp yarns under tension or both the filling and warp are allowed to shrink and the warp yarns later are restretched. Sloan (24) related

that better filling stretch properties are obtained if the warp is not allowed to shrink during processing.

Two-way stretch fabrics, as reported by American Fabrics Magazine (6), have the stretch factor incorporated into both the warp and filling directions. Two-way stretch fabrics by slack mercerization are produced by allowing the fabrics to shrink without tension. Two-way stretch cotton fabrics by slack mercerization are also comfort stretch fabrics, since they have only 10 per cent stretch in the warp and 20 per cent stretch in the filling, as reported by Sloan (23). These stretch percentages are actually lower than the one-way comfort filling stretch percentages of 25 to 30 per cent reported by American Fabrics Magazine (7). The amount of stress necessary to produce these percentages of stretch is very low.

#### Uses of Slack Mercerized Cotton Stretch Fabrics

Slack mercerized cotton stretch fabrics are comfortable to wear without binding or baggy feelings. They are cool, absorbent, and free from clamminess. Many uses have been made of slack mercerized stretch fabrics. Fox (14) stated that stretch fabrics are not universally applicable any more than one fiber is the proper one for all end uses. Cotton stretch fabrics have been used for socks, sportswear, children's clothing, pajamas, brassieres, gloves, blouses, shirts, pants, and diapers. Slack mercerized fabrics may be

molded into forms and used as braesiere cups, caps, women's shoes, and cloth portions of athletic shoes.

Cotton stretch fabrics may be used for articles other than apparel, such as slip covers and upholstery. Sloan (24) reported that slack mercerized fabrics may be used as coated fabrics for automobile upholstery and boat coverings. Slack mercerized fabrics have a potential use as molded articles, such as fabric covered dolls.

Slack mercerized fabrics were found by Perkins (20) to take flameproofing treatments without adverse results to the stretch property. In fact, in some cases, the flameproofing treatment imparted good wash-wear properties to the all-cotton fabrics.

#### Care of Slack Mercerized Cotton Stretch Fabrics

Care of slack mercerized cotton stretch fabrics has been the topic of study of several researchers. Cotton stretch fabrics were found to be washable. References did not agree as to the effects laundering had on the stretch and recovery properties of slack mercerized fabrics.

Home laundering followed by tumble drying was reported by Sloan (23, 24) to be an effective means of removing growth from slack mercerized fabrics that had been stretched 20 per cent or less. The stress-strain properties of the fabrics are not materially affected after twenty home launderings and tumble dryings, but there are losses in tearing and flex abrasion resistance.

McCalla (28) studied the effects of laundering on the stretch and recovery properties of slack mercerized cotton fabrics. Fabric stretch percentages were lower for the laundered fabrics than for the unlaundered fabrics. The interval and severity of the laundry treatment had adverse effects on the stretch properties. The fabrics laundered, regardless of the laundering frequency and laundering severity, showed more fabric growth than those not laundered, according to McCalla (28). However, the kind of laundering treatment showed significant difference on fabric growth. Vigorous home or commercial laundering with chlorine produced the greatest amount of fabric growth.

Hoover (26) set about to determine the comfort aspects and effects of commercial laundering on institutional uniforms made from slack mercerized cotton stretch fabrics, conventional cotton fabrics, and a combination of slack mercerized cotton stretch fabric and conventional cotton fabric. The uniforms were worn ten times and laundered after each wearing. At the end of the ten launderings all garments had less extensibility and more fabric growth present in the fabric than was available before laundering. Hoover explained that growth of the conventional cotton fabric was due to pressure and strains imparted to the fabric during pressing and finishing procedures in mass commercial laundering. The greatest amount of fabric growth occurred after the first laundering period for all fabrics. Recovery of

slack mercerized fabrics was well above the suggested standard for apparel garments.

It was concluded that slack mercerized cotton stretch fabrics may be home or commercially laundered. In either case the fabric will have less stretch and more growth than before laundering. The tearing strength and flex abrasion resistance may be lower for laundered slack mercerized fabrics than for laundered conventional fabrics.

### Fabric Stretch For Garment Construction

The major distinguishing property of stretch fabrics is, of course, the ability to be extended under stress and return to its original dimensions quickly or within a short period of time. This extensibility can range from very slight stretch to 30 per cent stretch for various cotton stretch fabrics. The question has arisen as to how much stretch a woven or knitted stretch fabric should have. Modern textile technology has enabled yarn producers and fabric manufacturers to engineer stretch fabrics which match the stretch factors in human skin under average circumstances.

A study of body flex in various positions was reported in American Fabrics Magazine (6). The percentages of stretch quoted are the percentages the body stretches or extends when movements are made. Back flex, across the shoulders is 13 to 16 per cent. The vertical, lengthwise flex of the elbow is 35 to 40 per cent, while the horizontal, circumference of the elbow flex is 15 to 22 per cent. The

vertical, lengthwise flex of the knee is 35 to 45 per cent, while the horizontal, circumference of the knee is 12 to 14 per cent. Seat flex across is 4 to 6 per cent.

J. P. Stevens and Company has suggested, in American Fabrics Magazine (6), the amount of stretch a stretch fabric may have for comfort based on the above body flex study. Tailored clothing may have 15 to 25 per cent stretch with no more than 2 per cent unrecovered stretch. Spectator sportswear may have 20 to 35 per cent stretch with no more than 5 per cent unrecovered stretch. Form-fit garments may have 30 to 40 per cent stretch with no more than 5 per cent unrecovered stretch. Active skiwear may have 35 to 50 per cent stretch with no more than 6 per cent unrecovered stretch. Sleek mercerized cotton stretch fabrics, based on Stevens' suggestions, are not suitable for form-fit or active skiwear, due to their low percentage of fabric stretch.

Lindberg (18, page 69) stated that "The idea that fabrics stretch should equal skin stretch is far too simplified and may well lead to wrong conclusions." Lindberg carried out research to determine the degree of stretch necessary for comfort in men's trousers cut in the normal way. It was found that clothing discomfort is due to excess pressure by the garment on different parts of the body; displacement of the garment at certain points, giving less aesthetic appearance; and the degree of tight fit of the garment. Fabric stretch in trousers is mainly in a direction from knee

to the seat when a man is stooping. Lindberg concluded that in trousers, and probably skirts, a fairly high degree of stretch is needed in the bias direction of the fabric. Fabrics having 30 per cent filling stretch will give good comfort in a garment worn below the waist. Easier stretch properties would be obtained at 50 per cent stretch. Increasing the stretch over 50 per cent will give progressively less and less gains in comfort. "Very high stretch values have no real importance for the comfort of ordinary loose-fitting garments," said Lindberg (18, page 73).

Cotton stretch fabrics by slack mercerization have an easy stretch of 20 to 30 per cent, but not as much as 50 per cent. It was concluded that slack mercerized cotton could be used for men's trousers. They would not provide the comfort that a fabric with 50 per cent easy stretch would.

### Clothing Construction Techniques

Bane (1) stated that when using stretch fabrics, intricate designs yield less desirable effects than simple designs. Stretch fabrics may be used for garments that can be made quickly.

Some precautions were suggested by Bane (1). Garments made from stretch fabrics may increase in size after wearing and laundering. Patterns that do not require lining and interfacing yield more favorable results. If a lining must be used, select stretch lining fabrics. If non-stretch interfacing must be used, cutting the non-stretch interfacing

on the bias may allow the interfacing to stretch as the outside fabric stretches. Bane recommended use of tape in seams where stretching is not desirable. Before cutting, allow the fabric to relax for twenty-four hours. Select patterns in the same size used for conventional non-stretch fabrics. Use a small machine needle for stitching on stretch fabrics. The use of zigzag stitches, fifteen stitches per inch and one-sixteenth of an inch wide with nylon or silk thread, were suggested. The machine tension should be balanced to yield well formed stitches. Use catch stitches or the tailored-hem for hemming. Press stretch fabrics like regular fiber.

#### Selected Related Studies

Several studies have been conducted on stitching techniques for man-made stretch fabrics and a few on slack mercerized cotton stretch fabrics. In these studies different stitching techniques have been undertaken on several stretch fabrics including cotton stretch fabrics to determine wearing qualities; effects of laundering; and tensile stress, strain and recovery properties of various kinds of seams using several kinds of sewing threads. It was found that no study on stitching techniques judged by appearance alone had been conducted on slack mercerized cotton stretch denim. Three studies on stitching techniques for stretch fabrics will be reported.

Jameon (22) directed research to evaluate some

wearing qualities of selected construction processes on stretch fabrics used in a basic garment design. Twenty-six experimental night shirts were constructed. All night shirts had the same design. Horizontal corespun stretch batists fabric, 61 per cent Dacron polyester, 32 per cent combed cotton, and 7 per cent Lycra spandex, was used in the study. Group I garments were constructed using ten stitches per inch, number one tension setting, and light presser bar pressure. Group II garments were constructed using eighteen stitches per inch, number nine tension setting, and heavy presser bar pressure. Plain seams were stitched with straight stitches and zigzag stitches.

The garments were constructed to test eighteen construction processes. After eighteen wearings and eighteen launderings, these processes were rated on each garment by a panel of four clothing instructors for seam appearance as determined by the amount of seam puckering, yarn slippage, and stitch breakage.

Group I garments, with ten stitches per inch, yielded more favorable results in tests for seam puckering, seam breaking strength, and seam elongation. No evidence of yarn slippage was observed in Group I. More decrease in seam length was evidenced by this group.

Group II garments, with eighteen stitches per inch, yielded more favorable results in tests for stitch breakage and dimensional changes in seam length. Group II garments

had the best general appearance; however, Group I garments rated higher for serviceability than Group II. Stitch breakage was evident in Group I and Group II; however, Group II garments rated higher.

The plain straight stitched seams yielded more favorable results than the zigzag seam. The breaking strength and elongation was higher for the plain seam than for the zigzag seam in both groups. The appearance of the straight stitched seam was rated higher than the appearance of the zigzag seam.

Jameon suggested that design details for garments made from stretch fabrics should be simple and cut with a minimum of pieces. Designs with straight lines and few pieces cut parallel with the stretch yarns give more favorable results. Use of buttons and buttonholes, either machine-made or bound, would give better results than zippers.

Richardson (29) conducted a study to determine the effects of seams on the tensile and elastic properties of two stretch fabrics. Fabric A had a twill weave, filling stretch, and was composed of 75 per cent Dacron polyester and 25 per cent cotton. Fabric B had a plain weave, filling stretch, and was composed of 60 per cent Dacron polyester, 32 per cent cotton, and 8 per cent Lycra spandex copolymer yarns. Two stitch types, plain and zigzag, were used on the specimens constructed zero degrees and 90 degrees to the fabric warp and on the unit weaves cell bisectors (bias). Taslan textured nylon sewing thread was used. Tests were

made with the seams parallel and perpendicular to the direction of stress using grab strip specimens.

It was found that seams parallel to the direction of stress restricted elongation in the bisector and filling directions, both at break and at low loads, so that work absorption values were also reduced. Sewing thread break occurred prior to specimen rupture. Because of yarn slippage and opening of the seams, elongation and work absorption values were slightly higher for seams which were perpendicular to the direction of stress than for unseamed specimens. Breaking load values were much lower for seamed specimens than those for unseamed specimens because of sewing thread failure in many cases. The use of zigzag stitches slightly increased the work absorption above that of the plain stitch, but also tended to increase immediate set in the amount of seam grinning in Fabric B when specimens were stressed in the filling directions and the seams were perpendicular to the direction of stress.

Richardson concluded that presence of a stretch yarn in a fabric radically changes its behavior under stress applied at varying angles to the warp from that of conventional fabrics. It would be recommended that a plain rather than zigzag stitches be used for sewing seams in stretch fabrics.

The purpose of Stonecipher's (30) study was to determine the relative strength and elasticity of the plain seam

in stretch fabrics as controlled by (1) the type of stitch, fourteen to sixteen stitches per inch and fifteen zigzag stitches per inch; (2) type of thread, number 50 mercerized thread and Taslan textured nylon thread; and (3) handling of fabric during machine stitching, let glide (not pushing nor holding back on fabric as it progresses toward presser foot) during stitching and stretching during stitching. Slack mercerized 100 per cent cotton filling stretch denim was used. All specimens were stitched with seams perpendicular to the selvages. Strength and elasticity were determined by testing on an inexpensive individually designed and constructed instrument.

It was found that in all cases, except one, the fabric broke before the seam. It was not necessary to stretch the fabric during stitching to improve strength and elasticity when mercerized thread and fifteen zigzag stitches per inch or Taslan and fifteen straight stitches per inch, Taslan and fifteen zigzag stitches per inch were used. The fabric should be stretched during stitching to produce maximum stretch when fifteen stitches per inch and mercerized thread were used. Over a 24-hour recovery period the recovery of the seams sewed on test fabrics was not affected by the type of stitch, thread, and method of handling during machine stitching. Stonecipher concluded that either of the methods of stitching, selected threads, or methods of handling fabric during machine stitching tested would be satisfactory.

Research findings from Richardson (29) and Stonecipher (30) concerned with seam strength were not in agreement. Methods of procedures were more similar than dissimilar. Richardson (29) used twill and plain weave filling stretch fabrics. The fiber content was man-made fibers and cotton in both cases. Specimens cut parallel and perpendicular to the selvages and on the bias were stitched in plain seams with straight and zigzag stitches using Taslan textured nylon sewing thread. Seam strength was tested by use of grab strip specimens. Stonecipher (30) used one fabric. The filling stretch fabric had a twill weave. The fiber content was 100 per cent cotton. Specimens cut perpendicular to the selvages were stitched in plain seams with straight and zigzag stitches using Taslan textured nylon and mercerized cotton, number 50 sewing threads. Seam strength was tested by use of an instrument designed and constructed by Stonecipher. Richardson's findings were that sewing thread break occurred prior to specimen rupture. Stonecipher's findings were that in all cases, except one, the fabric broke before the seam.

#### Summary of Review of Literature

Four processes have been developed for producing cotton stretch fabrics. Of the four processes evolved for producing stretch cottons, three have been designed for imparting stretch to cotton yarns and the fourth for imparting stretch to cotton fabrics after weaving. All four processes

are still under development or improvement.

Apparently more research and more satisfactory results have been achieved by the fourth process, slack mercerization, than by the other methods of imparting stretch to cotton. A great deal of research has been reported on slack mercerization. Slack mercerization process may be used to produce cotton stretch fibers, yarns, and fabrics. Slack mercerization of cotton fabrics after weaving has been the most successful to date.

Woven and knitted slack mercerized cotton stretch fabrics and garments made from them present a fashionable, inexpensive approach to a neat, well-fitted appearance. They can be cool, absorbent, easily laundered, and free from clamminess for summer wear. Cotton stretch fabrics produced by yarn treatments, still under development, claim to make stretch cottons that are thick, lightweight insulators for winter wear. These fabrics may help eliminate the need for exact sizes, especially in children's clothing and men's socks, because of the stretch properties. Woven and knitted stretch cotton fabrics have good recovery and high crease recovery. Cotton stretch fabrics may take on darker colors when dyed than non-stretch cotton fabrics. The breaking strength of stretch cotton is lower than for non-stretch cotton fabrics. The tensile strength and tear strength are about the same for stretch as for non-stretch cotton fabrics.

Cotton stretch fabrics can make contributions not

only in wearing apparel for men, women, and children, but also in the area of upholstery for home and industry. These fabrics will easily fit around irregular shapes, making them useful as slip covers and upholstery fabrics.

Stretch cotton fabrics may be laundered. Some loss of fabric stretchability, recovery power, tearing strength and flex abrasion resistance may be evident.

Recommendations for sewing with stretch fabrics were made by four researchers. It was suggested that straight stitches rather than zigzag stitches be used in plain seams. Approximately ten to eighteen stitches per inch were suggested for maximum strength and stretchability.

## CHAPTER III

### METHODS OF PROCEDURE

This study was undertaken to determine seam stitching techniques for slack mercerized cotton comfort filling stretch denim fabric with the seams judged for quality of appearance on the right side. Seam samples were constructed with four variables:

1. Type of seam
  - a. Plain seam
  - b. Flat felled seam
2. Stitches per inch
  - a. Nine stitches per inch
  - b. Fifteen stitches per inch
3. Sewing thread
  - a. Taslan textured nylon
  - b. Mercerized cotton, number 50
  - c. Dual Duty, cotton and Dacron polyester, number 60
4. Fabric grain
  - a. Parallel to selvages
  - b. Perpendicular to selvages
  - c. Seventy-two degree angle
  - d. Sixty-five degree angle

Fabrics and sewing threads to be used for the construction of seam samples were selected.

### Selection of Fabrics

Cotton stretch denim was selected as a result of a market survey of ready-made stretch trousers for women, Table I, page 59. Seven department stores in downtown Kansas City, Kansas, and Kansas City, Missouri, were surveyed on June 10 and 11, 1966. It was found that seventeen different styles of trousers for women were available in stretch denim. Of that number, five were all-cotton stretch denim.

The survey of stretch fabrics in yard goods, Table II, page 61, revealed that out of seven stores, six department stores and one specialty store, surveyed in downtown Kansas City, Kansas, and Kansas City, Missouri, only two stores had stretch fabrics in yard goods. One fabric store had two bolts of cotton stretch denim, four bolts of cotton and man-made fiber combination stretch denim, and one bolt of cotton stretch twill. A department store had six bolts of cotton stretch duck.

The slack mercerized all-cotton stretch denim fabrics were purchased on the open market. Both were comfort fitting stretch fabrics. Swatches of fabrics are shown in Plats I, page 70. In order to get fabrics from two bolts, fabrics in different colors were purchased. Both fabrics were manufactured by the same company and purchased in Kansas City, Kansas. The blue fabric was coded BS. The gray fabric was coded GS. Hereafter the fabrics will be referred to by their code letters.

Visual examination of BS fabric revealed that it was badly off-grain; that is, the warp yarns were not parallel to the selvages and the filling yarns were not perpendicular to the selvages. There was no known way for the person engaged in home sewing to straighten the fabric. The fact that BS fabric was off-grain may affect the results. GS fabric was straight.

BS fabric had sixty-six warp yarns and forty-seven filling yarns per square inch. GS fabric had sixty-eight warp yarns and forty-nine filling yarns per square inch. Both fabrics had warp yarns that were smaller than the filling yarns and had slightly wavy crimps. The larger filling yarns on both fabrics had saw-tooth crimps. The filling yarns on both fabrics varied in size, with some larger than others in a random arrangement.

The stretch denim fabrics had a sixty-three degree angle twill weave. The twill weave created upward diagonal lines left to right, with one filling yarn over one warp yarn and under two warp yarns.

#### Sewing Threads Used

Three types of sewing threads, manufactured by the same company, were used in this study:

1. Taslan textured nylon sewing thread
2. Mercerized cotton number 50 sewing thread
3. Dual Duty cotton and Dacron polyester number 60 sewing thread

### Preparation of Samples

Both fabrics were allowed to relax twenty-four hours before cutting. In order that seam appearance could be determined across the full width of the fabrics, the individual samples were cut before stitching. All samples were cut three inches away from the selvages. Samples were cut parallel to selvages, perpendicular to selvages, seventy-two degree angle, and sixty-five degree angle. The seventy-two degree angle and the sixty-five degree angles were calculated from right to left. These angles were used to simulate the angles at underarm, shoulder, center front, and center back seams in clothing construction. The straight grain samples were cut four inches wide and eight inches long. The samples cut off-grain to the warp were three inches wide at the upper section, four inches wide at the lower section, and eight inches long. Figure 1, page 69, illustrates these four seam angles.

A 201 Singer sewing machine with size eleven needle was used for stitching. The upper thread tension was set on two and one-half, and the bobbin tension balanced with that setting. These settings were not changed. The stitch regulator was set on seven and ten for stitching nine and fifteen stitches per inch, respectively. A straight stitch needle plate and straight stitch presser foot were used for seams. All seam samples were stitched with a straight stitch. Straight stitches were selected instead of zigzag stitches

on the basis of two research findings. Jameson (22) stated that the plain straight stitched seam yielded more favorable results than the zigzag seam. She further stated that the appearance of the straight stitched seam was rated higher than the appearance of the zigzag seam. Richardson (29) also recommended that a plain rather than zigzag stitch be used for sewing seams in stretch fabrics.

The seams in each group were stitched with like upper and bobbin threads, as Taelan upper thread with Taelan bobbin thread. Other seams were done in a like manner. All seams using the same kind of thread and the same number of stitches per inch were made before changing thread and stitch lengths.

Samples cut parallel to selvage and perpendicular to selvage were stitched in plain and flat felled seams with nine and fifteen stitches per inch using the three types of threads. Flat felled seams were made by stitching the wrong sides together with a five-eighths inch seam allowance. One seam allowance was trimmed to one-fourth inch, the other seam allowance turned under and edge stitched over the first. Plain seams were finished by separating the seam allowance, stitching, and pinking. Samples cut on seventy-two and sixty-five degree angles were stitched with plain seams only with nine and fifteen stitches per inch using the three types of threads. All seams were stitched with a five-eighths inch seam allowance.

The seam samples were pressed with a General Electric Steam and Spray iron on steam cotton setting. A metal ironing board with cotton fabric padding and silicone pad covered with cotton muslin was used for all pressings. The samples were pressed two times in the warp direction right and wrong sides to make certain the samples received the same number of pressings and that they were not stretched.

### Rating Procedure

The samples were displayed and rated in a clothing construction classroom with northern exposures, at Kansas State University. The lighting consisted of daylight and thirty-five overhead covered artificial fluorescent lights. The light fell on the samples from the side. The samples were numbered and mounted with pins on two large beige-colored boards. The bottom section of the boarding was held by the chalk trough, the upper section rested against the chalk board at a steep angle.

The samples were displayed in three rows, one-half inch apart, with six inches between rows. Seam samples of BS using the same kind of seam and like number of stitches per inch, stitched with the three types of threads were displayed together. Seams of GS using the same kind of seam and like number of stitches per inch, stitched with the three types of threads were displayed next to BS. For example: BS plain parallel to selvage seams with nine

stitches per inch using Taslan, mercerized cotton and Dual Duty sewing threads were placed one-half inch from GS plain parallel to selvage seams with nine stitches per inch using Taslan, mercerized cotton and Dual Duty sewing threads. Refer to Tables III through VII, pages 63 through 67 for the order of seams on display for judging.

Written instructions for judging seams on slack mercerized cotton stretch denim, page 52, were developed to explain the purpose of the judging, and the characteristics of the seams to be judged. Directions for the use of the rating forms, page 54, and rating procedures were given.

Criteria for judging seams from right side on slack mercerized cotton stretch denim, page 53, were based on Erwin's (2) standard for good seams. All items listed by Erwin as standard for good seams were not used. Only those items that could easily be recognized from the right side of the seam were used.

Rating instruments were tried out with two preliminary judges to determine if instructions for judging seams were clear and criteria for judging seams from the right side were appropriate. The two preliminary judgments were carried out under conditions that were to be used for final judgments. The preliminary judges were graduate students enrolled in the College of Home Economics at Kansas State University, summer session, 1966. One judge had a Bachelor's Degree in Clothing and Related Arts. The other judge had a minor in

General Home Economics.

Written instructions, criteria for judging seams from the right side, and rating forms were given to the preliminary judges prior to entering the display room. Each seam was rated according to the criteria as "very good," "adequate," or "unsatisfactory."

It was found that the diagonal lines of the twill weave made judging difficult. On the basis of that comment, the final judges were advised to stand at least two feet from the displayed seams, if the diagonal lines interfered with judging.

It was found that it was difficult not to touch the seams. The preliminary judges wanted to look at the undersides of the seams. It was explained that if each judge handled the seams, some distortions of the seams and samples might occur. No other revisions were suggested.

The five judges for the final ratings were graduate students with similar college training and experience, enrolled in the College of Home Economics at Kansas State University, summer session, 1966. All had Bachelor's Degrees in Home Economics Education or General Home Economics with two or more courses of clothing construction and clothing selection, and one or more courses in textiles at the college level. All had at least two years of teaching experience, having taught the year prior to summer school.

## CHAPTER IV

### FINDINGS

To determine stitching techniques for slack mercerized cotton filling stretch denim, seam samples were constructed using two cotton stretch denim fabrics and four variables. The seam samples were judged and rated on outside appearance. The importance of these variables on stitching techniques for the fabrics was analyzed according to the number of "very good," "adequate," and "unsatisfactory" ratings recorded for each seam sample.

The data with regard to ratings for BS and GS fabrics stitched with combinations of four variables is presented by discussion with charts and Tables III through VIII, pages 63 through 68. The discussion is presented in the same order as the variables were listed originally: type of seam; stitches per inch; sewing thread; and fabric grain.

#### Type of Seam

For each type of seam, plain and flat felled, twelve seam samples were constructed from BS fabric and GS fabric with samples cut parallel and perpendicular to selvages, stitched with three sewing threads, nine and fifteen stitches per inch. Each of the twelve seam samples received five ratings. The data for BS fabric plain and flat felled seam samples was recorded on Tables III through VI, pages 63

through 66. Data for GS fabric plain and flat felled seam samples was recorded on Tables III through VI, pages 63 through 66. Plain seam samples from BS fabric received a total of 25 "very good," 32 "adequate," and 3 "unsatisfactory" ratings. Plain seam samples from GS fabric received a total of 31 "very good," 27 "adequate," and 2 "unsatisfactory" ratings.

Flat felled seam samples from BS fabric received a total of 6 "very good," 36 "adequate," and 18 "unsatisfactory" ratings. Flat felled seam samples from GS fabric received a total of 22 "very good," 29 "adequate," and 9 "unsatisfactory" ratings. Listed below on a chart are the totals from above.

TOTAL RATINGS OF TWO STRETCH DENIM FABRIC SEAM SAMPLES  
STITCHED IN PLAIN AND FLAT FELLED SEAMS

<u>BS Fabric Seam Samples</u>	<u>GS Fabric Seam Samples</u>
Plain Seams	Plain Seams
25 "very good" ratings	31 "very good" ratings
32 "adequate" ratings	27 "adequate" ratings
$\frac{3}{60}$ "unsatisfactory" ratings	$\frac{2}{60}$ "unsatisfactory" ratings
Flat Felled Seams	Flat Felled Seams
6 "very good" ratings	22 "very good" ratings
36 "adequate" ratings	29 "adequate" ratings
$\frac{18}{60}$ "unsatisfactory" ratings	$\frac{9}{60}$ "unsatisfactory" ratings

### Stitches per Inch

Twelve seam samples were constructed from BS fabric and GS fabric for each of the two stitch lengths, nine and fifteen stitches per inch. Samples were cut parallel and perpendicular to selvages and stitched in plain and flat felled seams. Each of the seam samples in this group of twelve received five ratings. The data for BS fabric seam samples stitched with nine and fifteen stitches per inch was recorded on Tables III and IV, pages 63 and 64. Data for GS fabric seam samples stitched with nine and fifteen stitches per inch was recorded on Tables III and IV, pages 63 and 64. Seam samples from BS fabric stitched nine stitches per inch received a total of 16 "very good," 31 "adequate," and 13 "unsatisfactory" ratings. Seam samples from GS fabric stitched with nine stitches per inch received a total of 22 "very good," 31 "adequate," and 7 "unsatisfactory" ratings.

Seam samples from BS fabric stitched with fifteen stitches per inch received a total of 15 "very good," 37 "adequate," and 8 "unsatisfactory" ratings. Seam samples from GS fabric stitched with fifteen stitches per inch received a total of 31 "very good," 25 "adequate," and 4 "unsatisfactory" ratings. The totals from above are listed on the chart on the following page.

### Sewing Thread

For each of three sewing threads, Taslan, mercerized cotton, and Dual Duty, twelve seam samples were constructed

TOTAL RATINGS OF TWO STRETCH DENIM FABRIC SEAM SAMPLES  
STITCHED WITH NINE STITCHES PER INCH AND FIFTEEN  
STITCHES PER INCH

<u>BS Fabric Seam Samples</u>	<u>GS Fabric Seam Samples</u>
Nine Stitches Per Inch	Nine Stitches Per Inch
16 "very good" ratings	22 "very good" ratings
31 "adequate" ratings	31 "adequate" ratings
$\frac{13}{60}$ "unsatisfactory" ratings	$\frac{7}{60}$ "unsatisfactory" ratings
Fifteen Stitches Per Inch	Fifteen Stitches Per Inch
15 "very good" ratings	31 "very good" ratings
37 "adequate" ratings	25 "adequate" ratings
$\frac{8}{60}$ "unsatisfactory" ratings	$\frac{4}{60}$ "unsatisfactory" ratings

from BS fabric and GS fabric. Samples were cut parallel and perpendicular to selvages and stitched with nine and fifteen stitches per inch in plain and flat felled seams. Each seam sample in the group of twelve received five ratings. The data for BS fabric seam samples stitched with the three sewing threads was recorded on Tables III through VI, pages 63 through 66. Data for GS fabric seam samples stitched with the three sewing threads was recorded on Tables III through VI, pages 63 through 66. Seam samples from BS fabric stitched with Taslan sewing thread received a total of 17 "very good," 38 "adequate," and 5 "unsatisfactory" ratings.

Seam sample from BS fabric stitched with mercerized cotton sewing thread received a total of 13 "very good," 32 "adequate," and 15 "unsatisfactory" ratings. Seam sample from BS fabric stitched with Dual Duty sewing thread received a total of 16 "very good," 37 "adequate," and 7 "unsatisfactory" ratings.

Seam samples from GS fabric stitched with Taelan sewing thread received a total of 30 "very good," 28 "adequate," and 2 "unsatisfactory" ratings. Seam sample from GS fabric stitched with mercerized cotton sewing thread received a total of 18 "very good," 35 "adequate," and 7 "unsatisfactory" ratings. Seam sample from GS fabric stitched with Dual Duty sewing thread received a total of 30 "very good," 27 "adequate," and 3 "unsatisfactory" ratings. These totals for BS and GS fabric seam sample stitched with the three sewing threads are listed on the chart below.

TOTAL RATINGS OF TWO STRETCH DENIM FABRIC SEAM SAMPLES  
STITCHED WITH TAE LAN TEXTURED NYLON, MERCERIZED  
COTTON AND DUAL DUTY SEWING THREADS

<u>BS Fabric Seam Samples</u>	<u>GS Fabric Seam Samples</u>
Taelan Textured Nylon	Taelan Textured Nylon
17 "very good" ratings	30 "very good" ratings
38 "adequate" ratings	28 "adequate" ratings
5 "unsatisfactory" ratings	2 "unsatisfactory" ratings
<u>60</u>	<u>60</u>

BS Fabric Seam Samples

Mercerized Cotton number 50

13 "very good" ratings

32 "adequate" ratings

$$\frac{15 \text{ "unsatisfactory" ratings}}{60}$$

Dual Duty Cotton and Dacron polyester number 60

16 "very good" ratings

37 "adequate" ratings

$$\frac{7 \text{ "unsatisfactory" ratings}}{60}$$
GS Fabric Seam Samples

Mercerized Cotton number 50

18 "very good" ratings

35 "adequate" ratings

$$\frac{7 \text{ "unsatisfactory" ratings}}{60}$$

Dual Duty Cotton and Dacron polyester number 60

30 "very good" ratings

27 "adequate" ratings

$$\frac{3 \text{ "unsatisfactory" ratings}}{60}$$
Fabric Grain

For each of two fabric grains, parallel and perpendicular to selvages, twelve seam samples were constructed from BS fabric and GS fabric. Samples were sewn with three sewing threads, nine and fifteen stitches per inch and stitched in plain and flat felled seams. Each seam sample in the group of twelve received five ratings. The data for BS fabric seam samples cut parallel to selvages was recorded on Tables III and V, pages 63 and 65. The data for BS fabric seam samples cut perpendicular to selvages was recorded on Tables IV and VI, pages 64 and 66. Data for GS fabric seam samples cut parallel to selvages was recorded on Tables III and V, pages 63 and 65. The data for GS fabric seam samples cut perpendicular to selvages was recorded on Tables

IV and VI, pages 64 and 66.

Seam samples cut parallel to selvages from BS fabric received a total of 16 "very good," 28 "adequate," and 16 "unsatisfactory" ratings. Seam samples cut perpendicular to selvages from BS fabric received a total of 15 "very good," 40 "adequate," and 5 "unsatisfactory" ratings.

Seam samples cut parallel to selvages from GS fabric received a total of 23 "very good," 28 "adequate," and 9 "unsatisfactory" ratings. Seam samples cut perpendicular to selvages from GS fabric received a total of 30 "very good," 28 "adequate," and 2 "unsatisfactory" ratings. Total ratings for seam samples cut parallel and perpendicular to selvages are recorded on the chart below.

TOTAL RATINGS OF TWO STRETCH DENIM FABRIC SEAM SAMPLES  
CUT WITH THE GRAIN PARALLEL TO SELVAGES AND  
PERPENDICULAR TO SELVAGES

<u>BS Fabric Seam Samples</u>	<u>GS Fabric Seam Samples</u>
Parallel to Selvages	Parallel to Selvages
16 "very good" ratings	23 "very good" ratings
28 "adequate" ratings	28 "adequate" ratings
16 "unsatisfactory" ratings	9 "unsatisfactory" ratings
<u>60</u>	<u>60</u>
Perpendicular to Selvages	Perpendicular to Selvages
15 "very good" ratings	30 "very good" ratings
40 "adequate" ratings	28 "adequate" ratings
5 "unsatisfactory" ratings	2 "unsatisfactory" ratings
<u>60</u>	<u>60</u>

For each of two fabric grains, seventy-two and sixty-five degree angles to selvages, six seam samples were constructed from BS fabric and GS fabric. Samples were stitched nine and fifteen stitches per inch with three sewing threads in plain seams. Each seam sample in the group of six received five ratings. The data for BS fabric seam samples cut at seventy-two and sixty-five degree angles was recorded on Tablea VII and VIII, pages 67 and 68. Data for GS fabric seam samplea cut at seventy-two and sixty-five degree angles was recorded on Tables VII and VIII, pages 67 and 68.

Seam samplea cut at seventy-two degree angle to selvages from BS fabric received a total of 5 "very good," 25 "adequate," and zero "unsatisfactory" ratings. Seam samples cut at sixty-five degree angle to selvages from BS fabric received a total of 10 "very good," 6 "adequate," and 14 "unsatisfactory" ratings.

Seam aamples cut at seventy-two degree angle to selvages from GS fabric received a total of 14 "very good," 16 "adequate," and zero "unsatisfactory" ratings. Seam samples cut at sixty-five degree angles to selvages from GS fabric received a total of 11 "very good," 18 "adequate," and 1 "unsatisfactory" ratings. Total ratings from above for fabric grain cut on a seventy-two degree angle and sixty-five degree angle on BS fabric and GS fabric are shown on the following page.

TOTAL RATINGS OF TWO STRETCH DENIM FABRIC SEAM SAMPLES  
CUT WITH THE GRAIN AT SEVENTY-TWO AND SIXTY-FIVE  
DEGREE ANGLES TO SELVAGES

<u>BS Fabric Seam Samples</u>	<u>GS Fabric Seam Samples</u>
Seventy-two Degree Angle	Seventy-two Degree Angle
5 "very good" ratings	14 "very good" ratings
25 "adequate" ratings	16 "adequate" ratings
$\frac{0}{30}$ "unsatisfactory" ratings	$\frac{0}{30}$ "unsatisfactory" ratings
Sixty-five Degree Angle	Sixty-five Degree Angle
10 "very good" ratings	11 "very good" ratings
6 "adequate" ratings	18 "adequate" ratings
$\frac{14}{30}$ "unsatisfactory" ratings	$\frac{1}{30}$ "unsatisfactory" rating

Summary of Findings

GS fabric seam samples were rated higher than BS fabric seam samples in all cases. GS fabric seam samples received more "very good" and fewer "unsatisfactory" ratings than did BS fabric seam samples with one exception. Seam samples cut on a seventy-two degree angle from BS fabric and GS fabric received zero "unsatisfactory" ratings. The fact that BS fabric was badly off-grain may have affected the general appearance of BS fabric seam samples.

## CHAPTER V

### SUMMARY AND CONCLUSIONS

#### Summary

Use of stretch fabrics, cotton included, had presented construction problems for the clothing construction industry and for persons engaged in home sewing. It was the purpose of this study to determine seam stitching techniques for slack mercerized cotton comfort filling stretch denim.

Cotton stretch fabrics can be produced by four methods; however, slack mercerization has been the most successful to date. Slack mercerization imparts the stretch factor to cotton fabrics after weaving.

To determine stitching techniques for slack mercerized cotton stretch fabric, seventy-two seam samples were constructed using fabric from two bolts and four variables: type of seam; stitches per inch; sewing thread; and fabric grain. The seam samples were rated by five judges for right side seam appearance.

Fabrics from the two bolts were manufactured by the same company. BS fabric was badly off-grain and there was no known way for the person engaged in home sewing to straighten it. GS fabric was straight. Thread counts were similar. BS fabric had 113 yarns per square inch, 66 warp and 47 filling yarns. GS fabric had 117 yarns per square

inch, 68 warp end 49 filling yarns. It was found that more GS fabric seam samples yielded better right side seam appearance than BS fabric seam samples.

### Conclusions

Conclusions were made as to the importance of four variables on the right side appearance of seams for sleek mercerized cotton filling stretch denim fabric. Conclusions were based on findings derived from ratings recorded for seam samples constructed with four variables from two sleek mercerized cotton filling stretch denim fabrics.

On the basis of the individual seam sample ratings, it was determined that seams on sleek mercerized cotton comfort filling stretch denim fabric had favorable right side seam appearance when the machine upper thread tension was set on two and one-half, stitched in plain seams, fifteen stitches per inch with Taslen textured nylon sewing thread, and fabric grain perpendicular to selvages. Fabric grain perpendicular to selvages on both fabrics was rated higher than the seventy-two degree angle and the sixty-five degree angle. However, fabric grain at a seventy-two degree angle on both fabrics yielded better ratings for right side seam appearance than did fabric grain at sixty-five degree angle.

### Unanswered Questions

Research beyond the limits of this report is needed to show if sleek mercerized cotton filling stretch denim

fabric seam samples cut with fabric grain perpendicular to the selvages would yield better appearance than samples cut parallel to selvages after samples had been stretched and laundered. Several other questions have occurred as a result of this study. If seam samples from slack mercerized cotton comfort stretch denim were stitched with sewing threads other than those used in this report, would the results vary from those found here? Would other stretch fabrics, with greater or less stretch, yield similar results if stitched with Taslan textured nylon, mercerized cotton number 50, and Dual Duty cotton and Dacron polyester number 60? What would be the results if a cotton stretch fabric with a weave other than twill were used in the same method as slack mercerized comfort cotton stretch denim was used in this report?

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APPENDIX I

INSTRUCTIONS FOR JUDGING SEAMS ON SLACK MERCERIZED  
STRETCH DENIM

You have been asked to help obtain information for a master's report being done in the Department of Clothing and Textiles. Your willingness to take time to serve as a judge is appreciated.

Seventy-two seams are to be judged for outside appearance only. These seams have been made on slack mercerized cotton stretch denim. The seams vary according to:

type of seam  
number of stitches per inch  
kind of sewing thread  
grain direction

You have been provided with swatches of the two fabrics which may be tested for the stretch property. Please do not touch the seams.

Take out the rating form for slack mercerized stretch denim seams. The right sides of seams are displayed. Disregard the colors of sewing thread. Rate each seam individually according to the criteria provided. On the rating form, mark in the appropriate column for each seam rated. Do not discuss your decisions with the other judges. Any questions concerning the criteria for judging seams from right side will be answered before you view the seams.

CRITERIA FOR JUDGING SEAMS FROM RIGHT SIDE  
ON SLACK MERCERIZED STRETCH DENIM

Plain and flat felled seams on stretch denim are  
stitched and pressed so that:

The seams are:

1. flat
2. smooth
3. free of yarn dislocation
4. stitch length appears to be proportioned to the texture of the fabric
5. tension appears to be balanced
6. finished appearance is free of wrinkles
7. seam line is perpendicular to the floor (plumb line)

## RATING FORM FOR SEAMS ON SLACK MERCERIZED STRETCH DENIM

Very good means the seam meets all the criteria.

Adequate means the seam meets most of the criteria.

Unsatisfactory means the seam meets few of the criteria.

Check one rating for each numbered seam.

Seam	Rating		
Number	Very good	Adequate	Unsatisfactory
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			

Seam Number	Rating		
	Very good	Adequate	Unsatisfactory
16.			
17.			
18.			
19.			
20.			
21.			
22.			
23.			
24.			
25.			
26.			
27.			
28.			
29.			
30.			
31.			
32.			
33.			
34.			
35.			
36.			

Seam Number	Rating		
	Very good	Adequate	Unsatisfactory
37.			
38.			
39.			
40.			
41.			
42.			
43.			
44.			
45.			
46.			
47.			
48.			
49.			
50.			
51.			
52.			
53.			
54.			
55.			
56.			
57.			

Seam Number	Rating		
	Very good	Adequate	Unsatisfactory
58.			
59.			
60.			
61.			
62.			
63.			
64.			
65.			
66.			
67.			
68.			
69.			
70.			
71.			
72.			

## APPENDIX II

TABLE I  
PRELIMINARY MARKET SURVEY OF READY-MADE  
STRETCH DENIM TROUSERS FOR WOMEN  
JUNE 10 AND 11, 1966

Store number	Trouser style	Label information	Number of stitches per inch	Price
1	Jeans	Stretch Pants 75% cotton 25% nylon Sanforized	7	\$ 6.00
2	Jeans	Stretch Denim Grade School Fashions 75% cotton 25% nylon	9	\$ 2.99
3	Jeans	Stretch Denim 100% cotton	10	\$ 8.00
4	Jeans	Stretch Denim 72% cotton 28% nylon Swif-flex Sanforized	9	\$11.98
5	(No ready-made stretch pants)			
6	Jeans	Stretch Denim 100% cotton	10	\$ 8.00
6	Jeans	Stretch Denim 100% cotton Machine washable and dry-able	9	\$ 9.00
6	Jeans	Stretch Denim 100% cotton Machine washable and dry-able	12	\$ 8.00
6	Bermuda Shorts	Stretch Denim 75% cotton 25% nylon	11	\$ 5.00

TABLE I (continued)

Store number	Trouser style	Label information	Number of stitches per inch	Price
6	Shorts	Stretch Denim 75% cotton 25% textured cotton Comfortable, carefree, machine washable, re- covers quickly--springs back into shape Sanforized Good Housekeeping Seal	9	\$ 5.00
6	Bermuda Shorts	Stretch Denim 71% cotton 29% nylon Whipflex Action Wear Sanforized Mercerized Residual shrinkage not more than 1% Care of this fine fabric: Machine washable Do not use chlorine bleach Set automatic dryer on low temperature, or lay flat to dry For touchup ironing--use press cloth and low tem- perature setting Iron in non-stretch direction If dry cleaned advise cleaner of fiber content	9	\$ 4.00
6	Jeans	Stretch Denim 75% cotton 25% nylon Sanforized	7	\$ 6.00
6	Jeans	Stretch Denim 75% cotton 25% nylon Sanforized Residual shrinkage within 1%	10	\$ 4.00
7	Bermuda Shorts	Stretch Denim 71% cotton 29% nylon	9	\$ 4.98

TABLE II

PRELIMINARY MARKET SURVEY OF STRETCH DENIM IN YARD GOODS  
JUNE 10 AND 11, 1966

Store number	Label information	Price per yard
1	(No stretch denim fabric in yard goods)	
3	(No stretch denim fabric in yard goods)	
2	100% cotton twill, 36 inches wide, wash and wear	\$1.49
2	Stretch denim 65% Dacron polyester 35% cotton 48 inches wide	\$2.49
2	Stretch denim 75% cotton 25% nylon stretch 40 inches wide	\$1.98
2	Stretch denim 65% Dacron polyester 35% cotton 45 inches wide	\$2.49
2	Stretch denim 75% cotton 25% nylon stretch 36/38 inches wide	\$1.49
2	Stretch denim 100% cotton 42 inches wide	\$ .98
2	Stretch denim 100% cotton 45 inches wide Sanforized	\$ .98
4	(No stretch denim fabric in yard goods)	

TABLE II (continued)

Store number	Label information	Price per yard
5	(No stretch denim fabric in yard goods)	
6	Stretch Duck All cotton    Slack mercerized 2/3% Preshrunk Finished width 36 inches	\$ .79
7	(No stretch denim fabric in yard goods)	

TABLE III

RATINGS OF TWO STRETCH DENIM FABRICS STITCHED NINE  
STITCHES PER INCH WITH THREE TYPES OF THREAD  
AND TWO TYPES OF SEAMS CUT WITH SPECIMENS  
PARALLEL TO SELVAGE EDGES

FABRIC BS NINE STITCHES PER INCH										
Type of thread	Taslan textured nylon			Mercerized cotton			Dual Duty cotton and Dacron			
Seam number	1			2			3			
Ratings	V.g.	Ad.	Un.	V.g.	Ad.	Un.	V.g.	Ad.	Un.	
Plain seams parallel to selvages	0	5	0	2	1	2	0	4	1	
Seam number	25			26			27			
Flat felled seams parallel to selvages	2	2	1	0	2	3	1	2	2	
FABRIC GS NINE STITCHES PER INCH										
Type of thread	Taslan textured nylon			Mercerized cotton			Dual Duty cotton and Dacron			
Seam number	4			5			6			
Ratings	V.g.	Ad.	Un.	V.g.	Ad.	Un.	V.g.	Ad.	Un.	
Plain seams parallel to selvages	1	4	0	3	2	0	3	2	0	
Seam Number	28			29			30			
Flat felled seams parallel to selvages	1	2	2	1	2	2	1	3	1	

V.g. means very good; Ad. means adequate; Un. means unsatisfactory.

TABLE IV

RATINGS OF TWO STRETCH DENIM FABRICS STITCHED NINE  
STITCHES PER INCH WITH THREE TYPES OF THREAD  
AND TWO TYPES OF SEAMS CUT WITH SPECIMENS  
PERPENDICULAR TO SELVAGE EDGES

FABRIC BS NINE STITCHES PER INCH									
Type of thread	Taslan textured nylon			Mercerized cotton			Dual Duty cotton and Dacron		
Seam number	13			14			15		
Ratings	V.g.	Ad.	Un.	V.g.	Ad.	Un.	V.g.	Ad.	Un.
Plain seams perpendicular to selvages	5	0	0	2	3	0	4	1	0
Seam number	37			38			39		
Flat felled seams perpendicular to selvages	0	3	2	0	5	0	0	3	2

FABRIC GS NINE STITCHES PER INCH									
Type of thread	Taslan textured nylon			Mercerized cotton			Dual Duty cotton and Dacron		
Seam number	16			17			18		
Ratings	V.g.	Ad.	Un.	V.g.	Ad.	Un.	V.g.	Ad.	Un.
Plain seams perpendicular to selvages	3	2	0	3	2	0	1	3	1
Seam number	40			41			42		
Flat felled seams perpendicular to selvages	2	3	0	2	3	0	1	3	1

V.g. means very good; Ad. means adequate; Un. means unsatisfactory.

TABLE V

RATINGS OF TWO STRETCH DENIM FABRICS STITCHED FIFTEEN  
STITCHES PER INCH WITH THREE TYPES OF THREAD AND  
TWO TYPES OF SEAMS CUT WITH SPECIMENS  
PARALLEL TO SELVAGE EDGES

FABRIC BS FIFTEEN STITCHES PER INCH									
Type of thread	Taslan textured nylon			Mercerized cotton			Dual Duty cotton and Dacron		
Seam number	7			8			9		
Ratings	V.g.:	Ad.:	Un.:	V.g.:	Ad.:	Un.:	V.g.:	Ad.:	Un.:
Plain seams parallel to selvages	3	2	0	4	1	0	4	1	0
Seam number	31			32			33		
Flat felled seams parallel to selvages	0	3	2	0	0	5	0	5	0
FABRIC GS FIFTEEN STITCHES PER INCH									
Type of thread	Taslan textured nylon			Mercerized cotton			Dual Duty cotton and Dacron		
Seam number	10			11			12		
Ratings	V.g.:	Ad.:	Un.:	V.g.:	Ad.:	Un.:	V.g.:	Ad.:	Un.:
Plain seams parallel to selvages	2	3	0	0	4	1	4	1	0
Seam number	34			35			36		
Flat felled seams parallel to selvages	4	1	0	0	2	3	3	2	0

V.g. means very good; Ad. means adequate; Un. means unsatisfactory.

TABLE VI

RATINGS OF TWO STRETCH DENIM FABRICS STITCHED FIFTEEN STITCHES PER INCH WITH THREE TYPES OF THREAD AND TWO TYPES OF SEAMS CUT WITH SPECIMENS PERPENDICULAR TO SELVAGE EDGES

FABRIC BS FIFTEEN STITCHES PER INCH									
Type of thread	Taslan textured nylon			Mercerized cotton			Dual duty cotton and Dacron		
Seam number	19			20			21		
Ratings	V.g.	Ad.	Un.	V.g.	Ad.	Un.	V.g.	Ad.	Un.
Plain seams perpendicular to selvages	1	4	0	0	5	0	0	5	0
Seam number	43			44			45		
Flat felled seams perpendicular to selvages	1	4	0	0	4	1	2	3	0

FABRIC GS FIFTEEN STITCHES PER INCH									
Type of thread	Taslan textured nylon			Mercerized cotton			Dual Duty cotton and Dacron		
Seam number	22			23			24		
Ratings	V.g.	Ad.	Un.	V.g.	Ad.	Un.	V.g.	Ad.	Un.
Plain seams perpendicular to selvages	4	1	0	3	2	0	4	1	0
Seam number	46			47			48		
Flat felled seams perpendicular to selvages	3	2	1	2	3	0	2	3	0

V.g. means very good; Ad. means adequate; Un. means unsatisfactory.

TABLE VII

RATINGS OF TWO STRETCH DENIM FABRICS STITCHED NINE STITCHES PER INCH WITH THREE TYPES OF THREAD AND ONE TYPE OF SEAM CUT WITH SPECIMENS AT SEVENTY-TWO AND SIXTY-FIVE DEGREE ANGLES TO SELVAGE EDGES

FABRIC BS NINE STITCHES PER INCH									
Type of thread	Taslan textured nylon			Mercerized cotton			Dual Duty cotton and Dacron		
Seam number	49			50			51		
Ratings	V.g.	Ad.	Un.	V.g.	Ad.	Un.	V.g.	Ad.	Un.
Plain seams 72° angle to selvages	2	3	0	1	4	0	0	5	0
Seam number	61			62			63		
Plain seams 65° angle to selvages	2	3	0	3	2	0	1	3	1

FABRIC GS NINE STITCHES PER INCH									
Type of thread	Taslan textured nylon			Mercerized cotton			Dual Duty cotton and Dacron		
Seam number	52			53			54		
Ratings	V.g.	Ad.	Un.	V.g.	Ad.	Un.	V.g.	Ad.	Un.
Plain seams 72° angle to selvages	4	1	0	2	3	0	3	2	0
Seam number	64			65			66		
Plain seams 65° angle to selvages	1	4	0	1	3	1	3	2	0

V.g. means very good; Ad. means adequate; Un. means unsatisfactory.

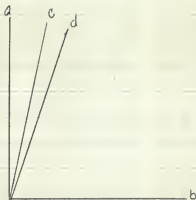
TABLE VIII

RATINGS OF TWO STRETCH DENIM FABRICS STITCHED FIFTEEN STITCHES PER INCH WITH THREE TYPES OF THREAD AND ONE TYPE OF SEAM CUT WITH SPECIMENS AT SEVENTY-TWO AND SIXTY-FIVE DEGREE ANGLES TO SELVAGE EDGES

FABRIC BS FIFTEEN STITCHES PER INCH									
Type of thread	Taslan textured nylon			Mercerized cotton			Dual Duty cotton and Dacron		
Seam number	55			56			57		
Ratings	V.g.	Ad.	Un.	V.g.	Ad.	Un.	V.g.	Ad.	Un.
Plain seams									
72° angles to selvages	0	5	0	1	4	0	1	4	0
Seam number	67			68			69		
Plain seams									
65° angles to selvages	1	4	0	0	1	4	3	1	1

FABRIC GS FIFTEEN STITCHES PER INCH									
Type of thread	Taslan textured nylon			Mercerized cotton			Dual Duty cotton and Dacron		
Seam number	58			59			60		
Ratings	V.g.	Ad.	Un.	V.g.	Ad.	Un.	V.g.	Ad.	Un.
Plain seams									
72° angles to selvages	3	2	0	0	5	0	2	3	0
Seam number	70			71			72		
Plain seams									
65° angles to selvages	2	3	0	1	4	0	3	2	0

V.g. means very good; Ad. means adequate; Un. means unsatisfactory.

**FIGURE 1****GRAIN DIRECTION USED FOR SEAM CONSTRUCTION**

- a. Parallel to selvage**
- b. Perpendicular to selvage**
- c. Seventy-two degree angle from lower right to upper left hand**
- d. Sixty-five degree angle from lower right to upper left hand**

## PLATE I

## COTTON COMFORT FILLING STRETCH DENIM FABRICS



Blue Cotton Stretch Denim



Gray Cotton Stretch Denim

STITCHING TECHNIQUES  
FOR SLACK MERCERIZED COTTON STRETCH DENIM

by  
LAVON E. BROILES WYNN

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AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of the  
requirements for the degree

MASTER OF SCIENCE

Department of Clothing and Textiles,  
Home Economics

KANSAS STATE UNIVERSITY  
Manhattan, Kansas

1967

Introduction and use of cotton stretch fabrics as yard goods has presented construction problems for persons engaged in home sewing with these fabrics. It was the purpose of this study to determine seam stitching techniques for slack mercerized cotton comfort filling stretch denim.

Fabrics from two bolts, manufactured by the same company, were used and found to be different. Blue fabric, coded BS, was badly off-grain and could not be straightened by the person engaged in home sewing. Gray fabric, coded GS, was straight. Thread counts were similar. Fabric BS had 113 yarns per square inch, 66 warp and 47 filling yarns. Fabric GS had 117 yarns per square inch, 68 warp and 49 filling yarns. It was found that GS seam samples yielded more favorable right side seam appearance than BS fabric seam samples.

Seventy-two seam samples were constructed using fabric from the two bolts, and four variables: type of seam (plain and flat felled); stitches per inch (nine and fifteen); sewing thread (Taslan textured nylon, mercerized cotton number 50, and Dual Duty cotton and Dacron polyester number 60; and fabric grain (parallel to selvages, perpendicular to selvages, seventy-two and sixty-five degree angles). The seam samples were rated on right side seam appearance by two preliminary judges to test the rating instruments and by five final judges.

On the basis of the individual seam sample ratings,

it was determined that seams on slack mercerized cotton comfort filling stretch denim fabric had favorable right side seam appearance when the machine upper thread tension was set on two and one-half, stitched in plain seams, fifteen stitches per inch with Taslan textured nylon sewing thread, and fabric grain perpendicular to selvages.